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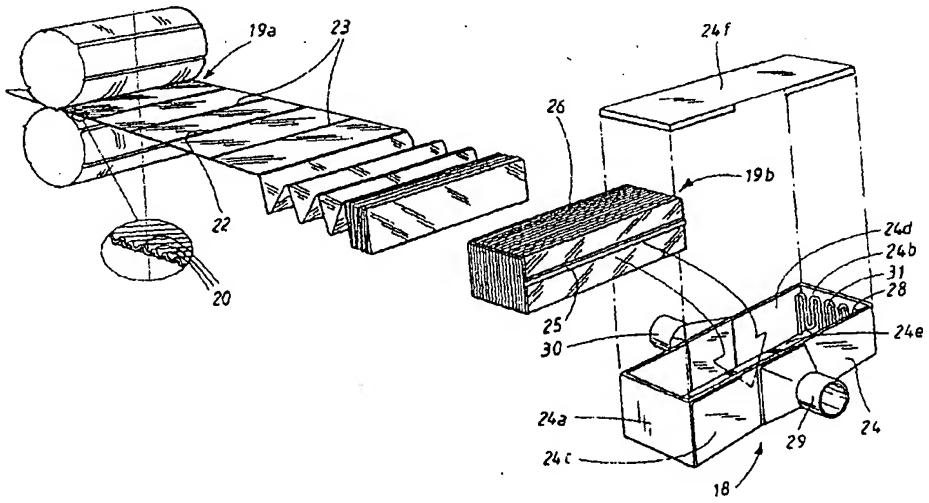
(54) Title: PROCEDURE AND DEVICE FOR TREATMENT OF A GAS FLOW



(57) Abstract: The invention relates to a method for treatment of a gas flow, comprising: guiding the gas flow through a gas treatment unit (18) adapted for filtering particles in said gas flow, and eliminating said particles in said gas treatment unit (18). The invention is characterized in that it comprises filtering particles in said gas flow by means of accumulating said particles in, or in connection with, a number of ducts (21) forming part of the gas treatment unit (21) during passage of the gas flow through the gas treatment unit (18), controlling the temperature of said gas flow along said ducts (21) to a value which provides combustion of said particles, and eliminating said filtered particles in said gas treatment unit (18) by means of combustion in said ducts (21). The invention also relates to device for accomplishing said method. By means of the invention, an improved treatment of a gas flow is provided, in particular in connection with exhaust gas purification in a diesel engine, for eliminating particles in its exhaust gases.

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Procedure and device for treatment of a gas flow

TECHNICAL FIELD:

The present invention relates to a method for treatment of a gas flow, comprising guiding the gas flow through a gas treatment unit adapted for filtering particles in said gas flow, and eliminating said particles in said gas treatment unit. The invention is particularly intended to be used for separating and eliminating particles in the exhaust gases from a combustion engine. The invention also relates to a device for accomplishing such a treatment of a gas flow.

BACKGROUND OF THE INVENTION:

In the field of vehicles which are operated by combustion engines, there is a general demand for low emissions of harmful substances in the exhaust gases from the engine. Said substances are primarily constituted by pollutants in the form of oxides of nitrogen (NO_x), hydrocarbon compounds (HC), and carbon monoxide (CO). As regards petrol engines, the exhaust gases are normally purified by means of an exhaust catalyst which forms part of the exhaust system and through which the exhaust gases are guided. In a so-called three-way catalyst, which is previously known, the major part of the above-mentioned harmful compounds is eliminated by means of known catalytic reactions. In order to optimise the function of the catalyst so that it provides an optimal degree of purification for NO_x, HC, and CO, the engine is in most operating conditions operated by a stoichiometric air/fuel mixture, i.e. a mixture where $\lambda=1$.

Furthermore, in the field of vehicles which are operated by means of a combustion engine, there is a demand for

low emissions of harmful emissions in the form of solid particles, primarily in the form of carbon particles, in the engine exhaust gases. This demand is for example valid in connection with diesel engines. In order to eliminate such particles, it is previously known to utilize various types of carbon filters. For example, ceramic filters are utilized today which are constructed with a porous wall structure by means of which particles in the exhaust gases can be deposited in the pores of the wall structure.

One disadvantage as regards a ceramic filter is that it must be regenerated at regular intervals, i.e. the particles which have been accumulated in the filter must be removed from the wall structure after some time of use. In this case, the regeneration suitably takes place by means of combustion of the particles at a certain increased temperature, normally 400-500° C, which for example can be obtained by means of a special electric heater. After this measure, the filter can once again be utilized for accumulating particles.

One particular type of particle filter is the so-called "city filter", by means of which the necessary temperature can be obtained so that said combustion of particles can take place. Although this type of filter in principle functions satisfactorily, it has certain disadvantages, e.g. that it on account of its construction discloses a comparatively high fall of pressure. Furthermore, it has a comparatively low filtration capacity by means of the fact that it is based on surface filtration along a comparatively small surface. Furthermore, the pressure loss over such a filter increases over the years, which is due to the fact that ashes gradually obstruct the filter. In addition, carbon can be accumulated during operation at low temperatures. When the vehicle subsequently increases the

load, spontaneous ignition may occur, wherein there is a risk of the filter being damaged permanently.

There are also other types of filters which are based on the fact that particles are gradually accumulated in a filter unit, which in that case is replaced after some time of use.

SUMMARY OF THE INVENTION:

The object of the present invention is to provide an improved treatment of a gas flow, in particular during exhaust gas purification in the form of particle filtration in connection with a combustion engine, by means of which the above-mentioned problems are solved in an effective manner. This is accomplished by means of a method as initially mentioned, the characterizing features of which will be apparent from appended claim 1. The object is also accomplished by means of a device as initially mentioned, the characterizing features of which will be apparent from appended claim 12.

The method according to the invention comprises guiding the gas flow through a gas treatment unit adapted for filtering particles in said gas flow, and eliminating said particles in said gas treatment unit. The invention is characterized in that it comprises filtering particles in said gas flow by accumulating said particles in, or in connection with, a number of ducts forming part of the gas treatment unit during passage of the gas flow through the gas treatment unit, controlling the temperature of said gas flow along said ducts to a value which provides combustion of said particles, and eliminating said filtered particles in said gas treatment unit by means of combustion in said ducts. The invention also relates to device for accomplishing such a treatment of a gas flow.

The invention is based on the fact that particles are accumulated in corrugations in said gas treatment unit and are kept in place while combustion of the particles takes place. Furthermore, the invention is provided with a heat exchanging function by means of which it is controlled that a combustion of the particles takes place at a sufficiently high temperature, which in turn is provided in an energy-saving manner. During the combustion, almost exclusively carbon dioxide is formed. Thus, according to the invention, a combined method for interchange of heat and filtration of particles is provided.

In this connection, the term "particles" is used in order to describe undesired emissions of solid particles in the form of primarily carbon which normally form part of the exhaust gases from a diesel engine or a corresponding engine which is adapted for operation with a surplus of oxygen.

Advantageous embodiments of the invention will be apparent from the appended dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS:

The invention will be further described in the following with reference to a preferred embodiment and to the annexed drawings, in which

Fig. 1 shows a simplified and principal view of an engine arrangement in which the present invention can be utilized,

Fig. 2 shows a manner of constructing a special exhaust gas treatment unit which is utilized according to the invention,

Fig. 3 shows said exhaust gas treatment unit slightly enlarged in comparison with Fig. 2, and

Fig. 4 shows a detail view of said exhaust gas treatment unit.

PREFERRED EMBODIMENTS:

Fig. 1 shows a schematic and simplified view of an arrangement according to the present invention. According to a preferred embodiment, the invention is arranged in connection with a combustion engine 1 in the form of a diesel engine. However, the invention is not limited for utilization in connection with merely diesel engines, but may be utilized for all types of combustion processes where an elimination of carbon particles in a gas flow is desirable, e.g. in connection with other types of combustion engines which at least periodically are operated by a surplus of oxygen. One example of an engine type where the invention can be utilized is a so-called DI engine, i.e. an engine of the direct-injected Otto cycle engine type, which is characterized in that it in certain operating conditions is operated by a large surplus of oxygen in the air/fuel mixture to the engine. During operation of a combustion engine of, for example, the diesel engine type or the DI engine type, exhaust gases are generated which contain carbon and other solid particles, wherein there is a demand for purification of the exhaust gases in order to eliminate the particles.

The diesel engine 1 according to Fig. 1 is in a conventional manner supplied with inflowing air via an air inlet 2. Furthermore, the engine 1 is provided with a number of cylinders 3 and a corresponding number of fuel injectors 4. The respective injector 4 is connected to a central control unit 5 via a corresponding electrical connection 6. The control unit 5 is preferably computer based and is adapted to control the fuel supply to each

injector 4 with fuel from a fuel tank 7 in a known manner so that an air/fuel mixture which is adjusted in every given moment is supplied to the engine 1, i.e. via the respective injector 4. In this regard, the control of the air/fuel mixture to the engine 1 is adjusted to the prevailing operating condition.

The control of the engine 1 takes place in an essentially known manner depending on various parameters which reflect the operating condition of the engine 1 and the vehicle in question. For example, the control of the engine can take place depending on the prevailing degree of throttle application, the engine speed, the amount of supplied air to the engine and the temperature of, for example, the cooling medium and the fuel of the engine. To this end, the control unit 5 is provided with a number of measuring signals 8. Said measuring signals 8 correspond to incoming parameters from a corresponding number of detectors, which symbolically are indicated by the reference numeral 9 in Fig. 1.

The method for controlling a diesel engine, e.g. as regards its fuel supply depending on the prevailing load and engine speed, takes place in a manner which is per se previously known and is therefore not described in further detail here. However, it can be mentioned that fuel is supplied from said fuel tank 7 and through a fuel filter 10 via a first fuel line 11. After filtering the fuel, it is guided further on to a fuel pump 12 via a second fuel line 13. From the fuel pump 12, the fuel is supplied to each injector 3 via corresponding additional fuel lines 14. The system also comprises a return line 15 for unused fuel from the respective injector 3 and back to the fuel tank 4. According to prior art, the fuel pump 12 is utilized for generating the necessary fuel pressure that is required during injection and combustion in the respective cylinder 3.

During operation of the engine 1, its exhaust gases are guided out from the cylinders 3 via a branch pipe 16 and further on to an exhaust pipe 17 which is connected to the branch pipe 16. In accordance with the invention, a unit 18 is provided further downstream along the exhaust pipe 17 for treatment of exhaust gases, in this case in the form of exhaust gases from the engine 1. The construction and the function of this exhaust gas treatment unit 18 will be described below in detail with reference to Figs. 2, 3 and 4. From the exhaust gas treatment unit 18, the exhaust gases are guided further out into the surrounding atmosphere, according to what is indicated schematically by means of an arrow in Fig. 1.

According to what in particular is apparent from Fig. 2, the exhaust gas treatment unit 18 comprises a strip 19a of metal, which by means of a suitable method (e.g. pressing or rolling) has been formed with corrugations 20 which extend in a predetermined angle in relation to the longitudinal direction of the strip 19a. This angle can amount to 0-90°, and suitably within the interval of 30°-60°. The strip 19a is repeatedly folded in a zigzag form so that it forms a strip package 19b. In this manner, an arrangement is formed where the above-mentioned corrugations 20 run crosswise in relation to each other in adjacent layers in the strip package 19b. Moreover, the corrugations 20 function as spacers, by means of which several ducts or slits 21 (see in particular Fig. 4) are formed which are separated from each other and through which a gas flow is intended to flow, in the present case thus a flow of exhaust gases from the engine 1.

The flow pattern in the ducts 21 is of such a kind that the flow in the duct is constantly mixed and has a satisfactorily contact with the walls of the ducts 21. Moreover, according to what is shown in Fig. 2, the

corrugations 20 can, in order to facilitate the folding of the strip, be interrupted at regular intervals in order to be replaced with folding notches 22, 23 which run at right angles to the strip 19a.

Furthermore, the strip 19a is enclosed in a heat insulated external container 24 (the insulation is not shown in the drawings). Said external container 24 is essentially rectangular and comprises two end walls 24a, 24b, two sidewalls 24c, 24d, a lower wall 24e, and an upper wall 24f. The strip package is sealed against the two sides 25, 26 which are arranged in parallel with the flow direction of the gas flow through the strip package. However, the end sections of the strip package are not sealed, but end in two return chambers 27, 28, according to what is apparent from in particular Fig. 3.

Furthermore, the external container 24 comprises an inlet which is provided with a sleeve 29 for connection of inflowing gas and an outlet which is provided with an additional sleeve 30 for connection of outflowing gas. By means of the folding of the strip, connection takes place in a simple manner from the side of the package to all ducts on one side of the strip package 19b, which is due to the fact that the two nozzles 19, 30 connect to a respective side of the strip. The inlet and outlet, respectively, of the external container 24 are preferably situated essentially centrally on the respective sidewall 24c, 24d. This corresponds to the fact that the inlet and the outlet, respectively, are positioned at essentially the same distance from the respective end wall, 24a, 24b. By means of this division of the gas flow in two flows with only half the speed, the pressure loss decreases considerably.

According to the present invention, the strip package 19b is utilized for filtering and eliminating particles,

primarily in the form of carbon, from the exhaust gases which are emitted from the engine 1 and guided into the exhaust gas treatment unit 18 via the exhaust pipe 17 (cf. Fig. 1). More precisely, the strip package 19b is formed in such manner that particles in this exhaust gas flow will be accumulated in the above-mentioned corrugations 20, which in this way function as separation elements by means of which said particles can be separated from the gas flow. The invention is based on the fact that the corrugations are utilized for collecting the particles, which will remain in place along the corrugations 20 for a sufficiently long time, so that they eventually will be combusted. This accumulation of particles on the strip package 19b takes place by means of the fact that the exhaust gas is repeatedly relinked to a new direction of motion by means of which the particles will show a tendency to fall out of the exhaust gas stream and instead adhere to the surface of the strip package 19b, i.e. along the corrugations 20. This accumulating function of the exhaust gas treatment unit 18 is obtained on the one hand by means of the fact that the particles, due to their comparatively high density, have a tendency to move in a more linear manner than the gas, and on the other hand by means of the fact that particles which come close to the surface or the wall will be attracted by it. The latter takes place by means of e.g. electrical forces and so-called van der Waals forces. Furthermore, the turbulent flow which the corrugations cause results in that the gas is constantly mixed so that all particles eventually will come close to the wall.

Furthermore, according to what will be described in detail below, an increased temperature (normally approximately 400-500° C) can be generated in the strip package 19b during operation of the engine 1. This can take place either by means of a special control of the

composition of the exhaust gases (which in turn can take place by injecting for example hydrocarbon compounds in the exhaust flow, or by means of a special control of the engine 1) or by means of a special heater element or by means of a heat exchanging function of the strip package 19b (or by means of a combination of these measures). All in all, this results in that particles which have been accumulated in the corrugations 20 will be combusted either continuously or intermittently when the temperature is sufficiently high. During the combustion, the particles are in this way eliminated while carbon dioxide is formed.

It can be noted that a surplus of oxygen is necessary in the exhaust gas while the accumulated particles are combusted. Thus, the invention can be utilized for engines which are adapted for operation with a surplus of oxygen (i.e. $\lambda>1$), but also for engines adapted for operation with an equilibrium of oxygen ($\lambda=1$) or a deficit of oxygen ($\lambda=1$). In the latter cases, combustion of carbon and other particles suitably can take place during intermittent occasions with a surplus of oxygen.

The invention can be utilized with various methods for filtration and separation of carbon particles from the gas flow in question. Below, some examples of methods for carbon separation will be described. According to a first embodiment, the invention can be utilized for providing a filtering process of the surface filtering type in which particles are accumulated in a coat or a layer, in this case on the surface of the strip package 19b. In order to provide this, preferably a porous catalytic coating or wall, suitably in the form of a (not shown) glass fibre mat or similar, can be laid out between the folds in the strip package 19b. Said mat can be provided along the entire extension of the strip package 19b, or at certain selected parts of the strip package 19b. Preferably, said

mat is provided between the surfaces of the strip package 19b (cf. Fig. 4), i.e. without this being in contact with the surfaces of the strip package 19b, by means of which the gas flow is influenced to pass through the mat. If the mat for example is laid out close to the respective return chamber 27, 28, it will be possible to control the temperature by means of a suitable engine control, according to what will be described in detail below. In this manner, the combustion of particles can be controlled. A similar function is obtained if the strip package 19b is provided with a fibre cloth, a net or some similar porous coat, which is capable of absorbing particles.

The basic principle of utilizing the above-mentioned mat is that the particles which are present in the gas flow will be accumulated and kept in the mat so that they can be combusted. According to a variant of this embodiment, said mat can be formed of catalytic material, which improves the filtering effect.

An alternative manner of separating particles is by providing the exhaust gas treatment unit 18 with a porous body which can be of a suitable material, e.g. foam, ceramic or a sand bed and which can be situated at a suitable place within its container 24. Such a type of filtering is of the deep filtering type, in contrast to filtering methods where particles are accumulated in a coat or a layer, which in that case is termed surface filtering according to what has been explained above.

One additional manner of separating particles in the exhaust gas treatment unit 18 according to the invention is to use the principle of electric filter, which is particularly suitable for filtration of comparatively small particles, more precisely of the order of <1μm. An electric filter is based on the utilization of a special

ionization unit (not shown in the drawings) which in that case suitably is provided in connection with the exhaust gas treatment unit 18, for example before (i.e. upstream of) the strip package 19b. Said ionization unit is per se previously known and is utilized for charging particles in the passing gas by means of ionization of the gas. Then, the charged particles can be influenced to fall out and be accumulated on earthed plates. In that case, according to a suitable form of the invention, said earthed plates are constituted by the actual strip package 19b, which to this end is connected to a (not shown) ground point. However, this variant of the invention is not limited to the ionization unit being situated upstream of the strip package 19b. Alternative placings, e.g. in one of the above-mentioned return chambers 27, 28, can also be suitable placings for such an ionization unit. The advantage as regards ionization of the gas in one of the return chambers 27, 28 (or both) is that the main part of the carbon particles in this way falls out close to the respective return chamber where the temperature is favourable for combustion of the particles. By placing the ionization unit before the strip package 19b, only one single small ionization unit is required, while two such units are required if ionization shall take place in the two return chambers 27, 28.

In order to facilitate filtering, an aggregation of small particles to larger particles can take place. This takes place by utilizing turbulence in the exhaust gas treatment unit 18. This takes place by means of the turbulence of the gas flow which the corrugations in the separation unit cause. Particles collide with each other and with the walls, by means of which electricity is transmitted. In this manner, attractive electric fields are formed. These large particles are subsequently

filtered out by means of one of the above-mentioned methods.

As mentioned above, a basic principle of the invention is that the particles which have been separated by means of the strip package 19b also can be eliminated in the exhaust gas treatment unit 18. Preferably, this takes place by means of combustion in the strip package 19b. In that case, the basic principle is that the invention is utilized in connection with such a control of the engine 1 that a temperature, which is sufficiently high for combustion of the particles, is generated in the exhaust gases, and thus also in the strip package 19b. On account of this, there is a demand for accurate temperature control of the exhaust gases. To this end, a basic principle of the invention is that an adjustment of the temperature of the prevailing gas flow takes place so that the temperature of active parts of the exhaust gas treatment unit 18 will be above a predetermined temperature limit at which combustion of particles can take place. As regards the heat exchanging function, it can be established that various parts of the exhaust gas treatment unit 18 normally have varying temperatures. More precisely, the temperature in the respective return chamber and its vicinity is normally higher than in the parts of the exhaust gas treatment unit 18 where the gas is guided in and out. The temperature limit at which combustion takes place is normally approximately 400-500° C. In order to achieve an increase of the temperature of the exhaust gas treatment unit 18, exothermic reactions, which occur as a consequence of the energy content in the exhaust gases, are utilized. Furthermore, an increase of the temperature can be obtained as a result of a change of the energy content in the exhaust gases by means of a suitable engine control, wherein the control unit 5 is utilized for this control. More precisely, this can be achieved by means of, for

example, a modification of the time for the injection and the ignition in the respective cylinder, or by means of additional injection of fuel during the exhaust stroke of the engine. An additional manner of providing an increase of temperature is by injecting air from an external source (not shown) into the exhaust gas treatment unit 18 during rich operation of the engine. An additional manner of providing an increase of temperature is by controlling the cylinders individually, wherein the exhaust gases from one or some of the cylinders 3 are operated in a rich manner whereas the rest of the cylinders are operated in a lean manner. This can result in a powerful exothermic reaction and a heat release.

The combustion of particles is facilitated if the strip package 19b is coated with some type of oxidation catalyst, or some other suitable type of catalyst, which provides catalytic oxidation of predetermined gas components, e.g. in the form of hydrocarbon compounds in the exhaust gases. In this way, the presence of such hydrocarbon compounds can be influenced by controlling the engine so that large contents of uncombusted hydrocarbons are generated in the exhaust gas. By means of oxidation of these hydrocarbons in the exhaust gas treatment unit 18, a drastic increase in temperature in the exhaust gas treatment unit is obtained, which in turn results in an effective particle combustion.

In case of the invention being utilized in diesel engines, it is not always suitable to operate the engine in a rich manner. In such a case, an increase in temperature can instead be obtained by injecting fuel directly into the exhaust gases after the engine or in connection with the exhaust stroke in the engine. In one such case, fuel (or some other reducing agent) can be dosed both before the exhaust gas treatment unit 18, e.g. in one of the return chambers 27, 28, and directly into

the exhaust gas treatment unit 18 between its inlet and the return chambers 27, 28 (or between the return chambers and their outlets).

Regardless of which method for heating the exhaust gases is utilized, it can be established that the invention is based on the fact that the engine 1 can be operated so that a sufficiently high temperature is generated in the strip package 19b, which in turn results in a combustion of the particles which have been accumulated in the corrugations 20. In this connection, the strip package 19b functions as a heat exchanger, wherein the exhaust gas flow takes place during interchange of heat between incoming and outgoing flows. The interchange of heat according to the invention is based on the fact that a sufficiently high temperature can be obtained with a comparatively low consumption of energy. In this way, this temperature exceeds a level at which the reaction of combustion can take place. More precisely, the interchange of heat can be utilized in order to provide a higher exhaust gas temperature than the exhaust gases have before they are guided into the exhaust gas treatment unit 18. Furthermore, the invention is based on the fact that the particles are accumulated and kept in the exhaust gas treatment unit 18 for a sufficiently long time in order for a combustion of the particles to take place at a temperature in the order of 400-500° C.

An additional possible manner of increasing the temperature of the gas flow is by means of externally supplied heat. According to what is shown in Figs. 2 and 3, this can, for example, take place by means of a special heater element 31. In that case, such a heater element 31 is suitably provided in each one of the return chambers 27, 28. The heater element 31 is formed of electrical heating conductors which are adapted for generating heat during connection to a separate (not

shown) voltage source. It can in particular be noted that even a comparatively small supply of heat in the return chambers by means of the heater element 31 results in an efficient increase in temperature. Thus, by means of a comparatively small supply of heat, an increase in temperature is obtained which is sufficient for combusting the carbon particles which have been filtered out.

The invention is not limited for utilization with the above-mentioned heater element. Alternatively, heat can be supplied externally by means of a gas or oil burner or an external fuel injection, which, however, are not shown in the drawings. According to an additional alternative, a heating function can be provided by means of a (not shown) supply of hot air (or some other suitable gas) from an external source.

Furthermore, the invention is not limited for utilization with an external supply of heat. Thus, such a supply can in principle be excluded for those applications in which a sufficiently high temperature can be generated without any externally supplied heat.

Thus, it can be established that the invention can be arranged in such manner that an increased temperature is generated by controlling the composition of the exhaust gases in a suitable manner, i.e. by selecting the concentration of various substances or gas components in the exhaust gas flow which in turn results in an increase in temperature which is necessary for elimination of particles by means of combustion. As mentioned above, this can be provided by means of an engine control which is adapted to its purpose (which in turn can be utilized for generating predetermined levels of, for example, hydrocarbon compounds in the exhaust gas flow), by means of injection of, for example, hydrocarbon compounds

directly into the exhaust gases or by injecting air into the exhaust gases. Alternatively, according to what has been mentioned above, the invention can also be arranged in such manner that an increase in temperature is obtained by means of externally supplied heat.

During operation of the engine 1, exhaust gases are supplied through the exhaust gas treatment unit 18. In this case, the exhaust gases are guided via the inlet 29 (cf. Figs. 2 and 3) and are divided into two partial flows 35, 36 (cf. Fig. 3). Said flows 35, 36, are guided through the ducts on one side of the strip package 19b and in the direction of the respective return chamber 27, 28. Initially, the supplied exhaust gases will be comparatively cold, but are gradually heated towards the reaction temperature at which combustion of particles can take place, according to what has been explained above. At the same time as hot exhaust gases are guided towards the outlet 30 of the exhaust gas treatment unit 18, additional exhaust gases enter via its inlet 29. In this case, heat will be transmitted from the outgoing gas flow to the incoming gas flow. By means of a satisfactorily heat exchange between the outgoing and the incoming gas flows, the local temperatures of said flows can be influenced to lie close to each other. For this reason, only a small additional supply of heat in the return chambers 27, 28 is required in order to, for example, increase the temperature of the gas flow. At the same time as the gas flow is heat-treated to the correct temperature in the exhaust gas treatment unit 18, it is guided over the corrugations 20 which constitute a filter, wherein the particles are accumulated and finally combusted as a consequence of the increased temperature.

The invention discloses an effective heat exchanging function, which in turn is utilized for facilitating the adjustment of the temperature of the exhaust gas

treatment unit which in turn results in a combustion of particles in the exhaust gases which functions optimally. In particular, the invention provides that a gas flow can be treated for filtration and elimination of particles at a certain temperature with a low heat consumption. During heating of the gas flow, a certain amount of heat (for a given gas volume) is consumed, which later on can be recovered for heating a new inflowing gas volume. This results in a heat exchanging effect which requires considerably less consumption of energy than traditional heating systems which, for example, are based on separate heater elements, e.g. of the electric type.

In the embodiments of the invention which comprise coatings of catalytic material, the strip package 19b can be formed in such manner that it is coated with a catalytic material which provides a function which corresponds to a three-way catalyst, i.e. which is utilized for catalytic elimination of undesired compounds in the form of nitric oxides, carbon monoxide and hydrocarbon compounds in the exhaust gases from the engine 1. Techniques for coating surfaces with thin coatings of catalytic material are previously known e.g. when manufacturing conventional car catalysts. Moreover, the strip package 19b can be provided with a NO_x reducing coating, i.e. a coating which provides a function which corresponds to a nitrogen oxide adsorbent (also called NO_x adsorbent). According to what is previously known, a NO_x adsorbent can in a known manner be utilized for reduction of NO_x compounds in the exhaust gases of the engine 1.

Thus, the exhaust gas treatment unit 18 can constitute an integrated component which is utilized as particle filter and which also comprises both NO_x reducing material (which thus constitutes a so-called NO_x adsorbent) and, where appropriate, material which provides the function

of a conventional three-way catalyst. In this manner, a combined effect against NO_x compounds and hydrocarbons as well as particles is provided. NO_x reduction is provided in the stoichiometric case by means of said three-way catalyst and in the lean case by means of the NO_x adsorbent.

The invention is not limited to said design as such an integrated unit which simultaneously functions as three-way catalyst and NO_x adsorbent, but may also be based on the fact that the exhaust gas treatment unit comprises for example NO_x adsorbing material and is connected to a separate unit in the form of a three-way catalyst. According to an additional alternative, the exhaust gas treatment unit can be formed without either a NO_x adsorbent or a three-way catalyst, wherein both these functions in that case can be provided by means of separate units along the engine's exhaust pipe. Whichever specific design is selected in the present application depends, for example, on how the space in the present vehicle can be utilized. Other factors which determine the selection of design are the demands for an acceptable heating effect, pressure loss and loss of heat and factors regarding the production and the cost.

According to an alternative embodiment, the engine 1 can be connected to a pre-catalyst (not shown) of the three-way type. Suitably, the pre-catalyst is provided with a comparatively low oxygen storage capacity and is provided upstream of the exhaust gas treatment unit 18 and preferably comparatively close to the exhaust manifold 16. In that case, such a pre-catalyst is particularly adapted for rapid heating during cold starts of the engine 1, i.e. so that its catalytic coating rapidly becomes active. This provides a considerable elimination of HC, CO, and NO_x compounds in the exhaust gases, particularly during low idle flows. Due to the fact that

the flowing exhaust gases can be heated rapidly by means of the pre-catalyst, a comparatively rapid heating is also provided for the subsequent exhaust gas treatment unit 18, i.e. a comparatively short time that passes until the exhaust gas treatment unit 18 has been heated to a temperature at which it is capable of combusting the harmful particles which are separated by means of the strip package 19b. This results in an efficient exhaust purification for the engine 1, particularly during cold starts.

In some cases, e.g. for protecting the material in the exhaust gas treatment unit 18 from too high temperatures which can occur during some operating conditions, cooling of the unit may come into question. If so, the temperature can be reduced in a number of ways, e.g. by means of external cooling. More precisely, this could be implemented by supplying for example water or air, which in that case is supplied through the exhaust gas treatment unit 18. This is not shown in the drawings. An additional manner is to utilize (not shown) cooling flanges in the exhaust gas treatment unit 18. In that case, said cooling flanges can be controlled by means of bimetals, which results in a system which can be utilized for temperature control without the need to utilize the control unit 5.

An additional possibility of reducing the temperature in the exhaust gas treatment unit 18 is to supply cold air, for example from an (not shown) air pump, into the return chambers 24. Due to the effect of the interchange of heat which is obtained according to the invention, even small amounts of supplied air results in a considerable temperature reduction of the gas flow through the exhaust gas treatment unit 18.

The supplied cold air can be non-compressed or compressed. According to one solution, the supplied air can be constituted by compressed air which is taken from the induction pipe of the engine, preferably after a (not shown) compressor forming part of a (not shown) turbo-aggregate. Alternatively, the cold air can be constituted by exhaust gases which are guided out from the exhaust manifold of the engine (before the turbo-aggregate) and which are cooled down (e.g. by means of a suitable form of after-treatment).

The main principle for external cooling is to carry off heat from the return chambers 27, 28 essentially without any mass exchange. During air injection, the heat that is present will be "diluted" and the temperature drops by means of supply of cold gas into the flow. In both cases, the principle of exchange of heat functions as a step-up exchange and results in a considerable enhanced effect as regards the temperature.

By means of an arrangement of the above-mentioned kind, an effective control of the temperature of the gas flow is obtained, so that said gas flow can be controlled and adjusted to a value which is optimally adjusted to the prevailing operating condition. This is particularly achieved by means of the fact that the design of the exhaust gas treatment unit 18 provides a satisfying heat transmission and a catalytic effect by means of a satisfying contact between the flowing gas and the walls in the exhaust gas treatment unit 18.

In order to facilitate the temperature control of the invention, the invention can comprise a (not shown) temperature sensor which is provided in connection with the exhaust gas treatment unit 18. In that case, such a temperature sensor can be connected to the control unit 5 via an electrical connection and deliver a measurement

value which corresponds to the prevailing temperature of the exhaust gas treatment unit 18. In that case, said measurement value can be utilized during the control of an increase and a reduction, respectively, of the temperature of the exhaust gas treatment unit 18, according to the methods which in turn have been explained above. In this manner, an accurate control of the temperature of the exhaust gas flow is provided. It is in particular suitable to utilize information regarding the temperature in the respective return chamber 27, 28, but information regarding the temperature in other parts of the exhaust gas treatment unit 18 may also be of interest. In such a case, more than one temperature sensor can be utilized for determinating the temperature in a corresponding number of points.

However, it shall be emphasized that the invention is not limited to merely the type of system which comprises such a separate temperature sensor, but the invention can also be realized by letting the control unit 5 comprise a program with a calculation model which predicts the temperature of the exhaust gas treatment unit 18 during various operating conditions with a satisfying accuracy.

The invention can be formed in order to prevent clogging of carbon and similar particles, i.e. in order to provide a high degree of filtration even after some time of use. This can be obtained by means of optimization of various parameters, e.g. the geometric design of the exhaust gas treatment unit 18, i.e. its length, width and height. Furthermore, the form and wave height of the corrugations 20 - as well as the distance between two adjacent corrugations - can be adjusted in order to prevent such clogging. In this regard, the control of the engine 1 can also be optimized.

Furthermore, the invention can be optimized in order to provide a lowest possible pressure loss. This can take place by means of an adjustment of the geometric construction of the exhaust gas treatment unit 18, i.e. its length, width and height.

The invention is not limited to the embodiment which is described above and shown in the drawings, but may be varied within the scope of the appended claims. For example, the strip 19a can be manufactured by a thin metal plate or foil, e.g. by rustless steel. This metal plate or foil can be coated with the above-mentioned catalytic material. Alternatively, the strip 19a can consist of a ceramic material which in that case has been impregnated or coated with the catalytic material. Furthermore, the material can alternatively be manufactured in the form of thin sheets or similar elements, which in that case are arranged in a package and subsequently are joined together along the edges so that the above-mentioned strip package 19a is formed.

If the exhaust gas treatment unit 18 comprises materials which provide the function of a three-way catalyst and a NO_x adsorbent, respectively, these materials can be arranged in various ways. For example, said materials can be situated on various areas along the exhaust gas treatment unit 18. For example, the inlet part of the exhaust gas treatment unit 18 can function as a three-way catalyst whereas the inner parts of the exhaust gas treatment unit 18 functions as a NO_x adsorbent. In that case, by means of a suitable design, the above-mentioned pre-catalyst 32 can also be eliminated.

The inlet and the outlet, respectively, of the exhaust gas treatment unit 18 can be positioned according to what has been explained above, i.e. essentially centrally on the respective side wall 24c, 24d. Alternatively, it is

possible to position the inlet and the outlet displaced towards either direction along the respective side wall. For example, this displacement can be of such a distance that the inlet will be situated right up in one end of the strip package. In such a case, only one return chamber is utilized.

The invention is not limited for utilization in connection with merely diesel engines, but can in principle be applied in all types of combustion processes where particles in the form of, for example, carbon are present in the exhaust gases from engines which at least periodically are operated by a surplus of oxygen.

Generally, the invention is not limited for utilization in connection with motor vehicles, but may be applied in other connections where there is a demand for filtering particles in a gas flow.

CLAIMS:

1. Method for treatment of a gas flow, comprising:

guiding the gas flow through a gas treatment unit (18) adapted for filtering particles in said gas flow, and

eliminating said particles in said gas treatment unit (18),

c h a r a c t e r i z e d i n that it comprises:

filtering particles in said gas flow by accumulating said particles in, or in connection with, a number of ducts (21) forming part of the gas treatment unit (21) during passage of the gas flow through the gas treatment unit (18),

controlling the temperature of said gas flow along said ducts (21) to a value which provides combustion of said particles, and

eliminating said filtered particles in said gas treatment unit (18) by means of combustion in said ducts (21).

2. Method according to claim 1,

c h a r a c t e r i z e d i n that said temperature control of said gas flow takes part by means of exchange of heat between the ducts (21), wherein the ducts (21) are connected to an inlet and an outlet, respectively, of the gas treatment unit (18) so that the gas flow takes part during exchange of heat between incoming and outgoing flows of said gas flow.

3. Method according to claim 1 or 2, wherein said gas flow is constituted by a flow of exhaust gases from a combustion engine (1),

c h a r a c t e r i z e d i n that said temperature control of said gas flow takes place by means of at least one of the following measures:

i) controlling the injection time and the ignition sequence of said engine (1) so that an increased gas temperature is obtained,

ii) controlling said engine (1) wherein additional injection of fuel is made during the exhaust stroke of the engine,

iii) controlling said engine (1) periodically between rich and lean operation,

iv) injecting air from an external source and into the exhaust gas treatment unit (18) during rich operation of the engine (1),

v) controlling the cylinders individually, wherein the exhaust gases from one or some of the cylinders of the engine (1) are operated in a rich manner whereas the remaining cylinders are operated in a lean or stoichiometric manner,

vi) supplying heat through a heater element (31) which is provided in the exhaust gas treatment unit (18),

vii) injecting fuel in the exhaust gases after the engine (1),

viii) oxidizing uncombusted hydrocarbons in said exhaust gas treatment unit (18).

4. Method according to any of the preceding claims, c h a r a c t e r i z e d i n that said filtering is made by means of surface filtering in said exhaust gas treatment unit (18).

5. Method according to any of claims 1-3, c h a r a c t e r i z e d i n that said filtering is made by means of deep filtering in said exhaust gas treatment unit (18).

6. Method according to any of claims 1-3, c h a r a c t e r i z e d i n that said filtering is made by means of an electric filter, wherein said accumulation of particles takes place on an earthed element in said exhaust gas treatment unit (18).

7. Method according to any of claims 1-6, c h a r a c t e r i z e d i n that said filtering is made during turbulent flow of said gas, for mixture of said gas.

8. Method according to any of the preceding claims, c h a r a c t e r i z e d i n that it comprises reducing undesired emissions in said gas flow by means of a catalytic coating in said ducts (21).

9. Method according to claim 8, c h a r a c t e r i z e d i n that it comprises reducing NO_x compounds in said gas flow by means of said catalytic coating.

10. Method according to any of the preceding claims, c h a r a c t e r i z e d i n that it comprises determinating a measure regarding the temperature of said exhaust gas treatment unit (18) by means of at least one separate temperature sensor which is provided in connection with the exhaust gas treatment unit (18), wherein said measure is utilized during said control of the temperature.

11. Method according to any of claims 1-9, c h a r a c t e r i z e d i n that it comprises determinating a measure regarding the temperature of said exhaust gas treatment unit (18) by means of calculation models which are defined beforehand and which define a relationship between said temperature and the prevailing operating condition of the engine (1), wherein said

measure is utilized during said control of the temperature.

12. Method according to any of the preceding claims, characterized in that said control of the temperature of said gas flow takes place by means of a particular control of the composition of said gas flow.

13. Device for treatment of a gas flow, comprising a gas treatment unit (18) adapted for filtering particles in said gas flow and for eliminating said particles, characterized in that said gas treatment unit (18) is provided with a number of ducts (21) for filtering by means of accumulation of said particles in said ducts (21) during passage of the gas flow through the gas treatment unit (18), and that the gas treatment unit (18) is adapted for controlling the temperature of said gas flow to a value which provides combustion of said particles along said ducts (21).

14. Device according to claim 13, characterized in that the ducts (21) are connected to an inlet and an outlet, respectively, of the gas treatment unit (18) so that the gas flow takes place during interchange of heat between incoming and outgoing flows of said gas flow.

15. Device according to any of claims 13 or 14, characterized in that said exhaust gas treatment unit (18) is adapted for surface filtering of particles.

16. Device according to any of claims 13 or 14, characterized in that said exhaust gas treatment unit (18) comprises a structure for deep filtering of particles.

17. Device according to any of claims 13 or 14, c h a r a c t e r i z e d i n that said exhaust gas treatment unit (18) comprises en electric filter for ionization of said particles, and an earthed element in said exhaust gas treatment unit (18) for eliminating said particles.

18. Device according to any of claims 13-17, c h a r a c t e r i z e d i n that the gas treatment unit (18) is adapted for generating a turbulent flow for mixing said gas.

19. Device according to any of claims 13-18, c h a r a c t e r i z e d i n that the exhaust gas treatment unit (18) comprises a catalytic coating in said ducts (21) for reducing undesired emissions in said gas flow.

20. Device according to any of claims 13-19, c h a r a c t e r i z e d i n that it comprises at least one temperature sensor which is provided in connection with the exhaust gas treatment unit (18), for determinating the temperature of said exhaust gas treatment unit (18).

21. Device according to any of claims 13-20, c h a r a c t e r i z e d i n that said exhaust gas treatment unit (18) comprises a strip (19a) which is folded into a package (19b), by means of which said ducts (21) are formed.

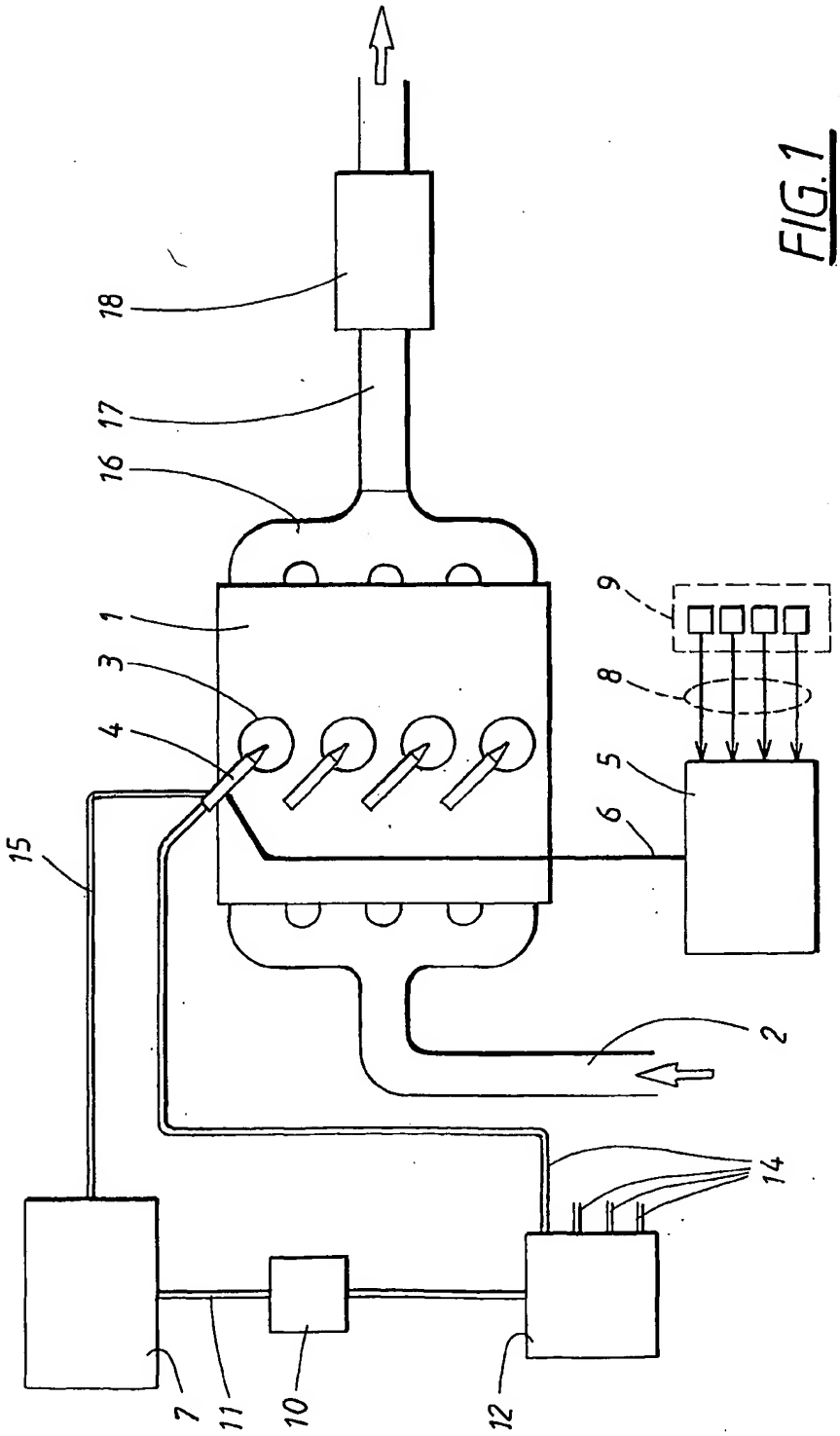

FIG.1

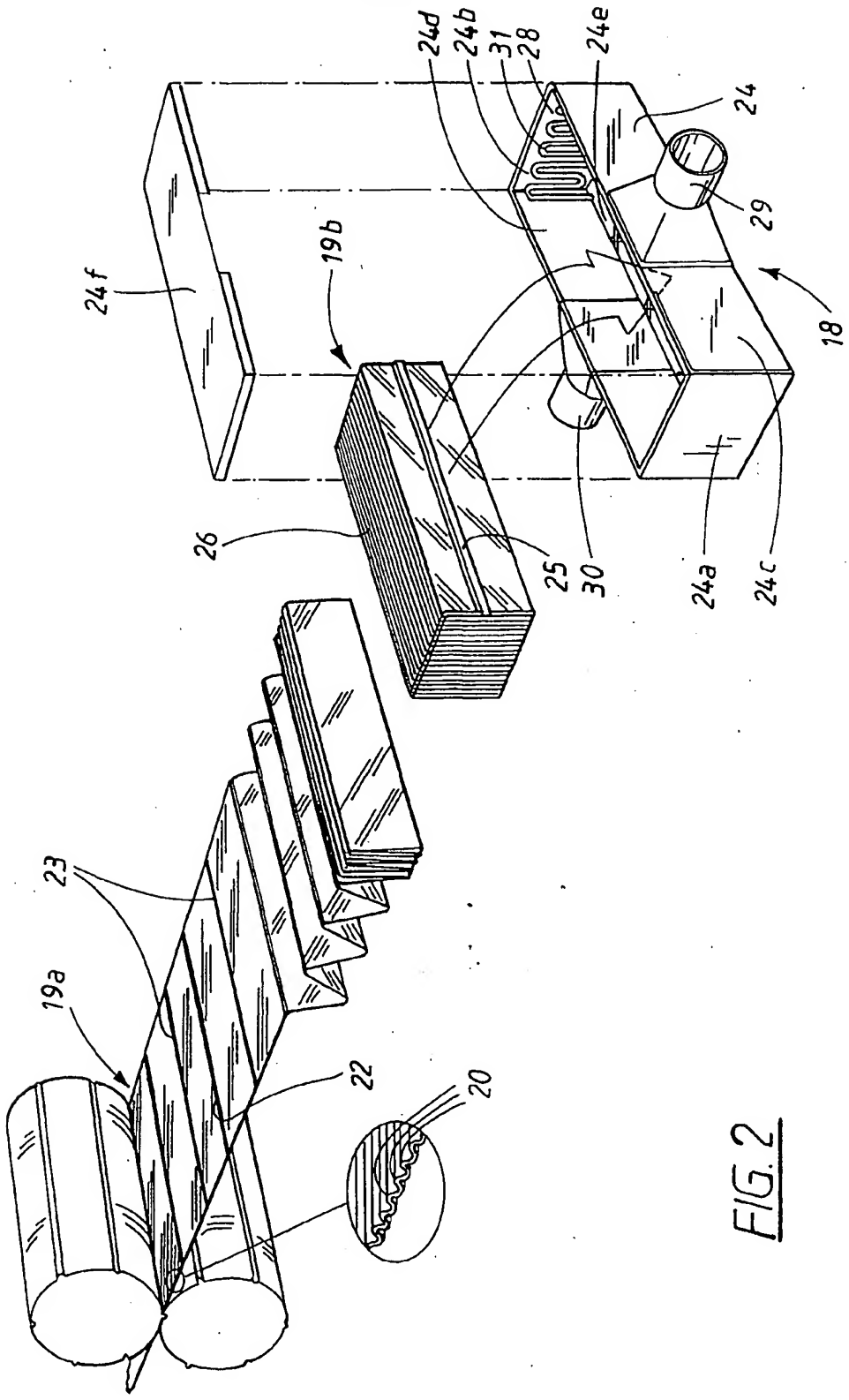

FIG. 2

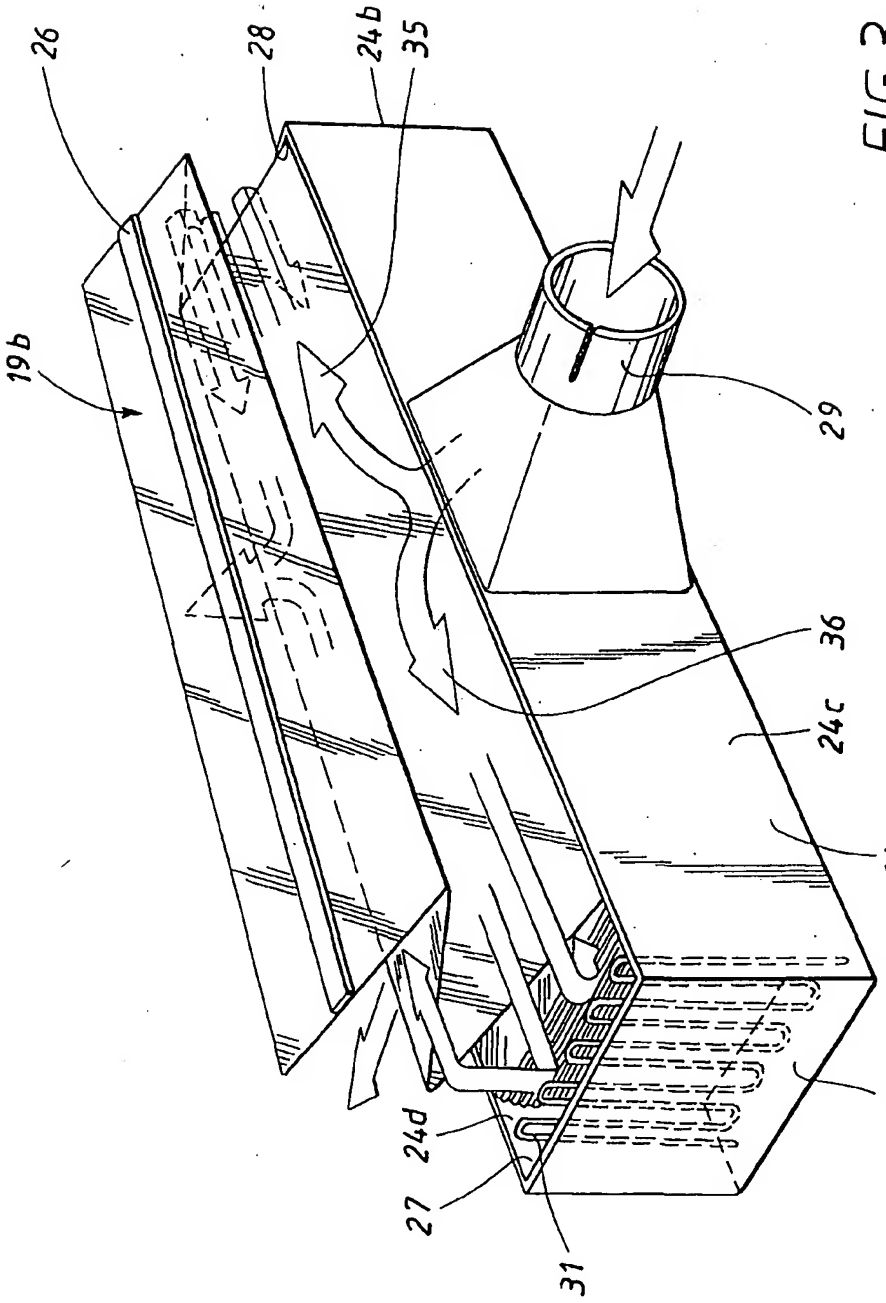

FIG. 3

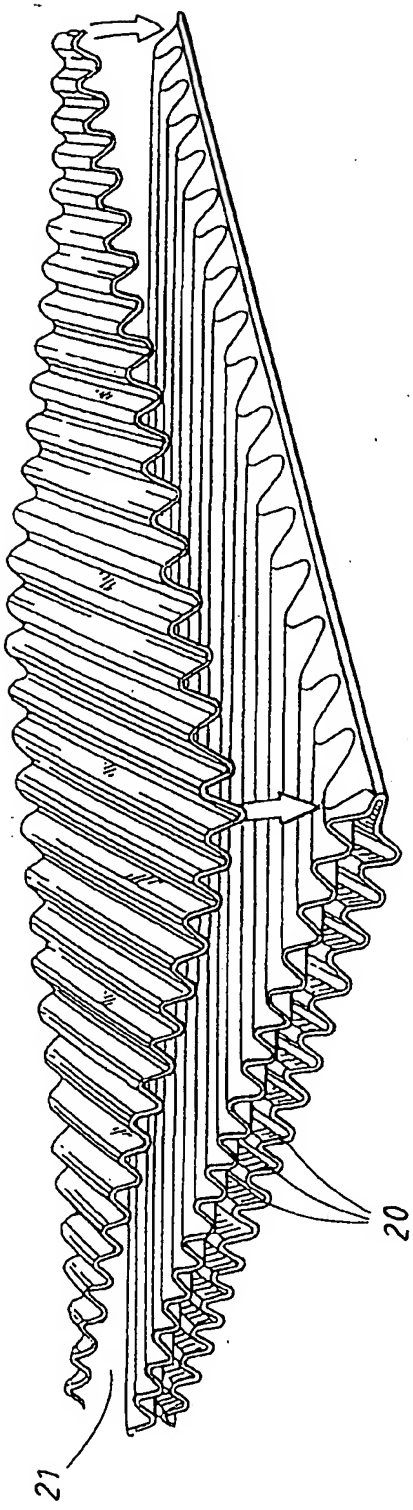

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02135

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F01N 3/023
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA, PAJ, EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0668437 A1 (FIRMA J. EBERSPÄCHER), 23 August 1995 (23.08.95), column 1, line 13 - line 39; column 6, line 36 - column 7, line 31, figures 1,3, abstract --	1-20
X	WO 9604509 A1 (HEED, BJÖRN), 15 February 1996 (15.02.96), figures 1-3, abstract --	13-21
X	EP 0504719 A1 (SCHWÄBISCHE HÜTTENWERKE GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG), 23 Sept 1992 (23.09.92), column 1, line 45 - line 55; column 6, line 43 - line 53, figures 1-2, abstract --	1-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 January 2002	21 -01- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Johan Westerbergh/ELY Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02135

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 9116529 A1 (AB VOLVO), 31 October 1991 (31.10.91), abstract --- ---	12

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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